Apprenticeship and Industry Training

Crane and Hoisting Equipment Operator - Mobile Crane Operator

Apprenticeship Course Outline

34-1-00 (2000)

Government of Alberta ■

Apprenticeship and Industry Training

CRANE AND HOISTING EQUIPMENT OPERATOR
Mobile Crane Operator

TABLE OF CONTENTS

Apprenticeship and Industry Training System 2

Local Apprenticeship Committee (L.A.C) 2

Provincial Apprenticeship Committee (P.A.C) 3

Alberta Apprenticeship and Industry Training Board 3

Safety Education 3

Legal and Administrative Aspects of Safety 4

Employer's Responsibilities 4

Employee's Responsibilities 4

Technical Training Establishments 4

Procedures for Recommending Revisions to the Course Outline 5

Apprenticeship Route Toward Certification 6

Crane and Hoisting Equipment Operator – Mobile Crane Operator Training Profile 7

COURSE OUTLINE

First Period Technical Training 9

Third Period Technical Training 32

© 2000, Her Majesty the Queen in right of the Province of Alberta, as represented by the Minister of Learning, 10th floor, Commerce Place, Edmonton, Alberta, Canada, T5J 4L5. All rights reserved. No part of this material may be reproduced in any form or by any means, without the prior written consent of the Minister of Learning.

Care has been taken to acknowledge all sources and references in these materials. If there are any inadvertent omissions, please contact Alberta Learning, 10th floor, Commerce Place, Edmonton, Alberta, Canada, T5J 4L5.

Apprenticeship and Industry Training System

Apprenticeship is post-secondary education with a difference. It helps ensure Alberta has a steady supply of highly-skilled employees, the foundation of our economy's future health and competitiveness.

Apprentices in more than 50 trades and crafts spend between one and four years learning their trade - 80% of the time on-the-job under the supervision of a certified journeyman or qualified tradesperson. The balance of the program is technical training in the theory, skills and technologies of their trade.

To become certified journeymen, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification - including the content and delivery of technical training - are developed and updated by the Alberta Apprenticeship and Industry Training Board (the Board) and a network of local and provincial industry committees.

The graduate of the Mobile Crane Operator apprenticeship training is a journeyman who will be able to:

- correctly use and care for tools and materials which are required to carry out the normal service and maintenance of the machines of the industry.
- operate and describe functions of the major and minor components of mobile cranes.
- recognise and identify malfunctions and the proper procedures related thereto.
- recognise and evaluate conditions which are potentially hazardous to safe machine operation.
- interpret and apply load chart and related documentation.
- work in conjunction and communicate with other trades, employers and customers.
- interpret and apply visual and audio communication.

While Alberta's apprenticeship system is supported by government, it is driven by industry (a term which includes both employers and employees). The Board steers the system, but the system relies on a network of local and provincial apprenticeship committees (LACs and PACs), representing the interests of each of more than 50 trades and crafts. Partners in the apprenticeship system play critical roles through the local and provincial committees within each trade.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the Board can set up a LAC. The Board appoints equal numbers of employees and employers for terms of up to three years. The committee appoints a member as presiding officer. LACs:

- monitor the apprenticeship system, and the progress of apprentices in their trade, at the local level
- help settle certain kinds of issues between apprentices and their employers
- recommend improvements in apprenticeship training and certification to their trade's provincial apprenticeship committee
- make recommendations to the Board regarding the appointment of members to their trade's PAC.

Provincial Apprenticeship Committees (PAC)

The Board establishes a PAC for each trade and, based on PAC recommendations, appoints a presiding officer and equal numbers of employees and employers for terms of up to three years. Most PACs have nine members. PACs:

- identify the training needs and content for their trade
- recommend to the Board the standards for training and certification for their trade
- monitor the activities of local apprenticeship committees in their trade
- make recommendations to the Board about the designation of trades and occupations
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in the trade
- may participate in resolving any apprenticeship-related disputes between employers and employees

Crane and Hoisting Equipment Operator PAC Members

Mr. R. Schram.....Edmonton.....Presiding Officer
Mr. B. Maccan.....Calgary.....Employer
Mr. R. Ross.....Calgary.....Employer
Mr. G. Chaba.....Edmonton.....Employer
Mr. R. Kerr.....Edmonton.....Employer
Mr. D. House.....Fort McMurray.....Employer
Mr. G. Rusling.....Vermilion.....Employer
Mr. C. Graham.....Edmonton.....Employee
Mr. J. Penner.....Edmonton.....Employee
Mr. M.Timmer.....Edmonton.....Employee
Mr. J. Lanoue.....Fort McMurray.....Employee
Mr. L. Schnepf.....Red Deer.....Employee

The Alberta Apprenticeship and Industry Training Board (Board)

The 13 members of the government appointed Board are aware of the training and certification needs of tradespeople and employers. Many Board members have previously served on an LAC or PAC. The Board:

- responds to industry's needs
- sets training and certification standards in all trades
- approves the technical training to be delivered by training establishments
- encourages the development of alternate methods of technical training delivery
- makes recommendations to the Minister of Alberta Learning about the designation of trades and occupations
- creates LACs, PACs, and appoints their members
- advises the Minister on the labour market's need for skilled and trained workers

Safety Education

Safe working procedures and conditions, accident prevention and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of employers and employees. Safe learning experiences and environments can be created by controlling the variables and behaviours that may contribute to or cause an accident or injury.

It is generally recognised that a safe attitude contributes to an accident free environment. Everyone will benefit as a result of a healthy safe attitude towards prevention of accidents.

A tradesperson may be exposed to more hazards than others in the work force. Therefore, tradespersons should be familiar and comply with the Occupational Health and Safety Act and Regulations respecting personal safety and the safety in the work place.

Legal and Administrative Aspects of Safety

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer and employee.

Employer's Responsibilities:

The employer is responsible for:

- provision and maintenance of safety equipment.
- provision of protective devices and clothing.
- enforcement of safe working procedures.
- safeguards for machinery, equipment and tools.
- observance of all accident prevention regulations.
- training of employees in safe use and operation of equipment.

Employee's Responsibilities:

The employee is responsible for:

- working in accordance with the safety regulations pertaining to job environment.
- working in such a way as not to endanger themselves or fellow employees.

Technical Training Establishments

The Crane and Hoisting Equipment Operator apprenticeship training program is offered by Alberta Learning, Apprenticeship and Industry Training . Staff and facilities for delivering the program are supplied by Souch Campus of N.A.I.T.

Procedures for Recommending Revisions to the Course Outline

This course outline has been prepared by the Industry Programs and Standards of the Apprenticeship and Industry Training in partnership with the Provincial Apprenticeship Committee for the trade.

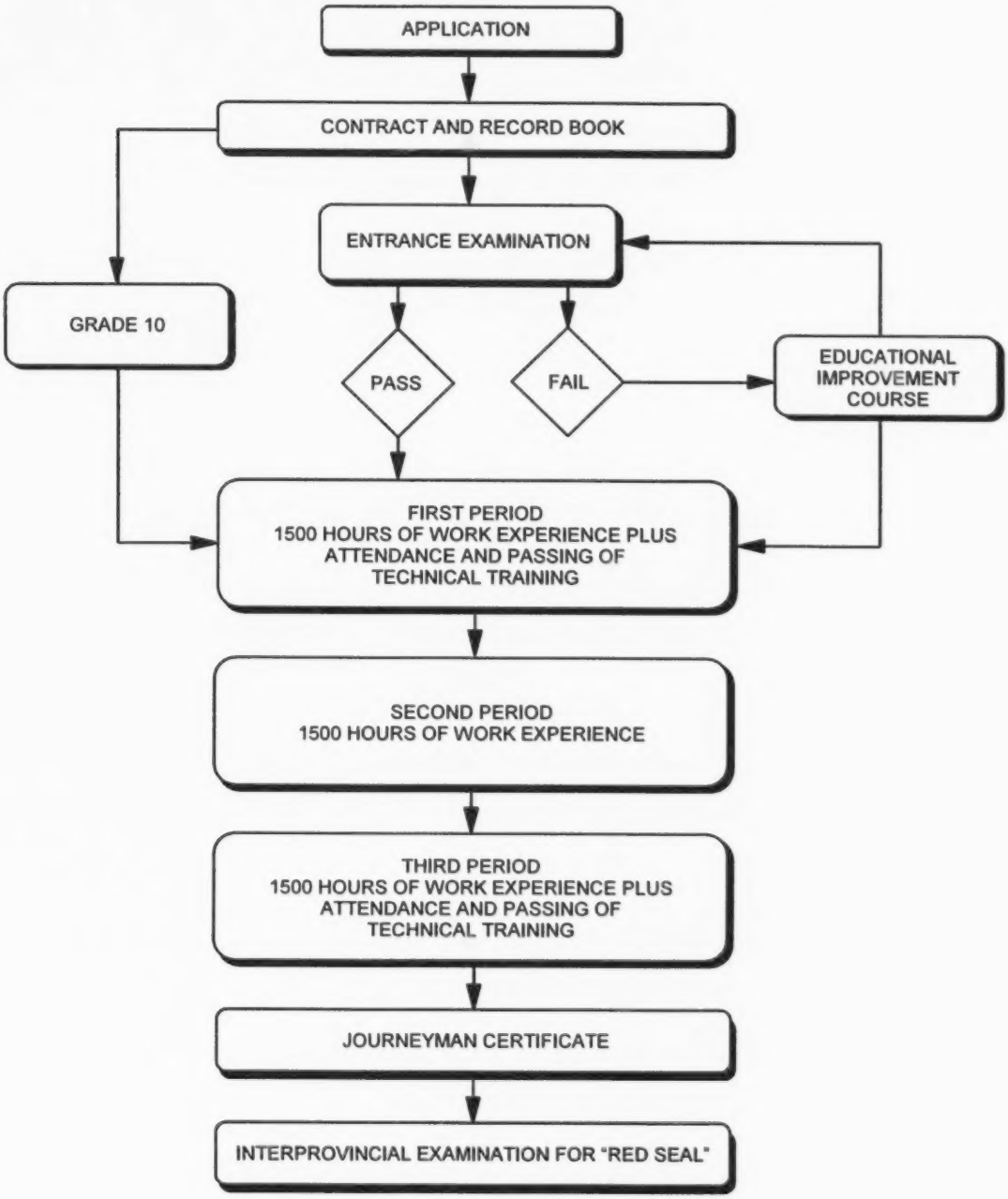
This course outline was approved on April 17, 2000 under the authority of the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. Valuable input is acknowledged from industry and the institute.

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to:

Apprenticeship and Industry Training
Industry Programs and Standards
10th floor, Commerce Place
10155 - 102 Street
Edmonton, AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

APPRENTICESHIP ROUTE TOWARD CERTIFICATION
CRANE AND HOISTING EQUIPMENT OPERATOR - MOBILE CRANE OPERATOR



Crane and Hoisting Equipment Operator
Mobile Crane Operator Training Profile

First Period

(6 Weeks 30 Hours Per Week - Total of 180 Hours)

SECTION ONE **INTRODUCTION TO MOBILE CRANES** **13.5 Hours**	⇨	**A** Introduction to Mobile Cranes
SECTION TWO **TRADE CALCULATIONS** **27 Hours**	⇨	**A** Basic Mathematics and Geometry
SECTION THREE **LOAD CHART READING** **27 Hours**	⇨	**A** Load Chart Reading
SECTION FOUR **INTRODUCTION TO OPERATING PROCEDURES** **27 Hours**	⇨	**A** Introduction to Operating Procedures
SECTION FIVE **RIGGING AND EQUIPMENT ACCESSORIES** **27 Hours**	⇨	**A** Rigging and Equipment Accessories
SECTION SIX **INSPECTION, TESTING AND MAINTENANCE** **9 Hours**	⇨	**A** Inspection, Testing and Maintenance
SECTION SEVEN **HYDRAULICS & APPLICATIONS TO MACHINE CONTROL** **13.5 Hours**	⇨	**A** Hydraulics & Applications To Machine Control
SECTION EIGHT **POWER TRAINS, CHASSIS AND SUSPENSIONS** **9 Hours**	⇨	**A** Power Trains, Chassis and Suspensions
SECTION NINE **DIESEL ENGINES AND SYSTEMS** **9 Hours**	⇨	**A** Diesel Engines and Systems (basic understanding)
SECTION TEN **RULES AND REGULATIONS RELATING TO THE TRADE** **18 Hours**	⇨	**A** Rules and Regulations Relating to the Trade

Third Period

(6 Weeks 30 Hours Per Week - Total of 180 Hours)

SECTION ONE **REVIEW OF MOBILE CRANES AND COMPONENTS** **9 Hours**	⇨	**A** Mobile Cranes and Components
SECTION TWO **PRINCIPLES OF CRANE OPERATION** **13.5 Hours**	⇨	**A** Principles of Crane Operation
SECTION THREE **LOADS CHARTS** **27 Hours**	⇨	**A** Loads Chart
SECTION FOUR **OPERATING PROCEDURES** **27 Hours**	⇨	**A** Operating Procedures
SECTION FIVE **INTRODUCTION TO PRE-LIFT PLANNING** **27 Hours**	⇨	**A** Pre-Lift Planning and Tasks
SECTION SIX **ADVANCED RIGGING PROCEDURES** **27 Hours**	⇨	**A** Advanced Rigging
SECTION SEVEN **INTRODUCTION TO NEW CRANES** **13.5 Hours**	⇨	**A** New Technology
SECTION EIGHT **CONVENTIONAL CRANE DRAW-WORKS** **13.5 Hours**	⇨	**A** Conventional Drive Principles and Operation
SECTION NINE **SPECIALISED LIFT ATTACHMENTS** **9 Hours**	⇨	**A** Attachments and Accessories
SECTION TEN **MULTI-CRANE LIFTS** **13.5 Hours**	⇨	**A** Multi-crane Lifts

The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

FIRST PERIOD TECHNICAL TRAINING
CRANE AND HOISTING EQUIPMENT OPERATOR
MOBILE CRANE OPERATOR
COURSE OUTLINE

TOPICS	OBJECTIVES **Upon successful completion of this unit the apprentice should be able to:**
SECTION ONE: ..... INTRODUCTION TO MOBILE CRANES ..... 13.5 HOURS	
A. Introduction to Mobile Cranes	
1. Basic types and configurations	1. Identify and explain the structural and operational characteristics of the cranes listed: a) boom trucks b) industrial cranes c) carrier-mounted lattice boom cranes d) crawler-mounted lattice boom cranes e) carrier-mounted telescopic boom cranes f) crawler-mounted telescopic boom cranes g) all terrain cranes h) rough terrain cranes i) heavy lift mobile cranes
2. Boom trucks	1. Explain the structural and operational characteristics of boom trucks. 2. Identify and describe the functions of the components listed: a) telescoping boom b) articulating i) truck chassis ii) rear/front stabilisers iii) turret or pedestal iv) swing circle v) base or heel section vi) telescopic powered and manual boom sections vii) boom extensions (jibs)
3. Carrier-mounted (truck crane)	1. Explain the structural and operational characteristics of carrier-mounted (truck cranes). 2. Identify and describe the function of the components listed: a) undercarriage or chassis b) swing circle, ring gear, roller path (turntable) c) outrigger boxes, beams and cylinders d) outrigger jacks or stabilisers and pads or floats e) front bumper jack or stabiliser (optional) f) outrigger controls g) front bumper counterweight (optional)
4. Telescopic boom cranes	1. Explain the structural and operational characteristics of telescopic boom cranes. 2. Identify and describe the function of the components listed: a) boom b) hoist or lift cylinder(s)

c) boom foot pins (hinge pins)
d) base or heel section
e) power telescoping sections
f) pinned boom sections
g) main and auxiliary boom tip sheave(s)
h) boom extension and jib stowed support
i) main hook block and auxiliary hook ball
j) hoist lines with LMI/anti two-block devices
k) jib
l) lattice boom extension (swingaway type jib)
m) A-frame jib
n) box section jib (stinger type)
o) luffing jib
p) jib deflection sheave
q) tip sheave
r) jib inserts (optional)
s) jib backstays (adjustable for jib offset)
t) jib forstays
u) jib mast

5. Lattice boom cranes

1. Explain the structural and operational characteristics of lattice boom cranes.

2. Identify and describe the functions of the components listed:
   a) boom foot (heel or base section)
   b) boom tip (head section)
      i) open throat tip (offset or inline)
      ii) tapered tip
      iii) hammerhead tip
   c) boom inserts (sections)
   d) transition section
   e) main chord
   f) pin connection lugs
   g) lacing or lattice members
   h) boom hoist reeving and drive
   i) boom stops or backstops
   j) boom hoist kick-out
   k) gantry - low and high
   l) inner bail and equaliser (bridle)
   m) live mast and bridle
   n) boom pendants (stays)
   o) boom mid-point suspension (optional)
   p) boom pendant spreader bar (optional)
   q) boom tip sheaves (lower and upper)
   r) main hook block
   s) hoist line with LMI/anti two block-device
   t) jib
   u) jib foot (heel or base section)
   v) jib inserts (sections)
   w) jib tip (head section)
   x) jib mast, strut or gantry
   y) jib pendants (forstays) (backstays)
   z) headache or overhaul hook ball
   aa) auxiliary hoist or whip line with LMI/anti two-block device

6.	Crane upperworks (superstructure)	1. Identify the main components of the crane upperworks listed: a) machinery deck/revolving frame b) slewing ring rollers or slewing bearing c) boom foot pins and lugs d) high mast foot lugs (on some models) e) counterweight f) boom hoist drums and drives (winches) g) centre of rotation (centre or king pin)
7.	Crawler-mounted (crawler crane)	1. Identify the main components listed: a) car body frame and axles b) swing circle, ring gear, roller path (turntable) c) side frames (extendable and not extendable) d) idler rollers e) track rollers (support rollers) f) tread sprockets or drive sprockets g) drive shaft sprockets and drive chains h) traction shafts i) hydrostatic track drive systems on modern crawler cranes

SECTION TWO:.....TRADE CALCULATIONS .....27 HOURS

A. Basic Mathematics and Geometry

1.	Calculator exercises	1. Perform trade calculations mentally, on paper, or with a calculator: a) subtract b) multiply c) divide d) multiply and divide e) change fractions into decimal f) fractions g) percentages h) feet and inches into feet i) area of rectangles j) circumference and area of circles k) metric conversion l) area (metric)
2.	Calculations	1. Perform calculations using accepted industry formulas for the items listed: a) load weights b) load distribution c) effect of sling angle d) sheave friction e) number of parts of line required
3.	Formulas a) slings safe working load	1. Calculate safe working loads for slings.

SECTION THREE:.....LOAD CHART READING .....27 HOURS

A. Load Chart Reading

1.	Basic terms and conditions	1. Interpret load charts for: a) boom length

		b) operating radius c) boom angle d) boom point elevation
a)	gross and net capacities	1. Define gross capacity vs net capacity.
b)	gross and net loads	1. Define gross load vs net load.
c)	75 and 85% factors	1. Calculate the percentage of the capacity load from the chart.
d)	structural or stability	1. Describe capacity limited by "structural or stability": a) shaded area used for structural rating b) bold line divides the two areas c) asterisks or stars used for structural rating
e)	areas of operation	1. Determine area of operation for: a) most stable b) less stable c) least stable d) where operations are prohibited
f)	boom lengths	1. Determine boom lengths: a) boom length definition b) boom length between chart listings c) calculate boom length by radius and boom angle
g)	boom angles	1. Determine boom angles: a) boom angle definition b) boom angle between chart listings c) determine boom angle using boom length and radius
h)	load radius	1. Determine load radius: a) load radius definition b) load radius between chart listings c) determine radius by using boom length and boom angle
i)	hoist lines	1. Identify and calculate load hoist lines: a) breaking strength b) safety factor c) safe working load 2. Determine the "parts of line" required. 3. Determine and calculate the "weight of line".
j)	range diagrams	1. Interpret range diagrams to: a) determine crane configuration b) determine boom clearance c) determine boom tip headroom
k)	load moment indicators	1. Use and describe the purpose of LMI/load moment indicators: a) central unit b) load transducers or load cells c) boom length and angle transducers d) anti-two block e) read out (inside cab)

TOPIC	OBJECTIVES	FIRST PERIOD
	2. Describe the various types of computers (introduction).	
l) rubber tire ratings	1. Determine "on rubber" ratings for: a) pick and carry b) "over the front" rating c) 360° rating d) tire condition and specifications	
2. Main boom capacities (no attachments)	1. Calculate capacities for the following: a) lattice booms b) full power telescopic booms c) pinned telescopic booms 2. Select "gross capacity" from (main boom) load chart. 3. Determine number of parts of line and hook required. 4. Deduct all hook blocks, headache balls and rigging. 5. Deduct weight of parts of line exceeding those allowed by the manufacturer.	
3. Main boom capacities (jibs and boom extensions installed)	1. Calculate capacities for: a) lattices booms b) full power telescopic booms c) pinned telescopic booms 2. Select "gross capacity" from (main boom) load chart. 3. Determine number of parts of line and hook required. 4. Deduct all hook blocks, headache balls and rigging. 5. Deduct effective weight of jib and/or extensions mounted. 6. Deduct auxiliary boom point and stowed jib and/or boom extension (if applicable). 7. Deduct weight of parts of line exceeding those allowed by the manufacturer.	
4. Boom extensions capacities	1. Calculate capacities for: a) full power telescopic booms b) pinned telescopic booms 2. Select "gross capacity" from (boom extension) load chart. 3. Determine number of parts of line and hook required. 4. Deduct all hook blocks and headache balls and rigging. 5. Deduct effective weight of jib if mounted. 6. Deduct auxiliary boom point and stowed jib (if applicable).	
5. Jib capacities	1. Identify and determine: a) jib types and length b) jib offset c) jib angle to the ground d) jib capacity for lattice booms	

e) jib capacity - full power telescopic booms
f) jib capacity - pinned telescopic booms
   i) jib capacities using one load chart
   ii) jib capacities using two load charts
   - structural capacity from jib chart
   - tipping capacity from boom chart
   - use lowest capacity from the two

6. Factors affecting capacity

1. Identify and explain how the following factors affect capacities:
   a) poor machine condition
   b) eccentric reeving
   c) improper use of outriggers
   d) ground condition
   e) off-level crane
   f) side loading
   g) increase of load radius
   h) rapid swing rate
   i) impact loading
   j) weather (wind, ice, moisture, frost)
   k) operator experience

7. Boom trucks'-load chart comprehension

1. Describe load charts for the boom trucks listed:
   a) introduction and types
      i) Manitex
      ii) JLG
      iii) Stinger
      iv) Pitman
      v) National
      vi) telescoping versus articulating
   b) legislation
   c) basic hydraulics and pre-operational checks
   d) stability and tipping
   e) capacity and load charts

2. Describe operating techniques.

3. Describe maintenance and inspection procedures.

SECTION FOUR: ..... INTRODUCTION TO OPERATING PROCEDURES ..... 27 HOURS

A. Introduction to Operating Procedures

1. Responsibilities

1. Identify the responsibility of each person regarding operating procedures for a lift:
   a) crane operator
   b) rigger/signal person
   c) site supervisor
   d) maintenance person(s)
   e) crane owner

2. Weights of loads

1. Identify weights of loads using available means:
   a) use of load weighing devices
   b) estimating weights using accepted industry formulas (volume, density and area)

		c) information shown on load itself d) sources of weight information, i.e.: drawings, shipping bills, catalogues, etc. e) using signs of crane tipping to estimate weight (test lift) not recommended
3.	Centre of gravity of the load	1. Identify the centre of gravity of the load: a) stable vs unstable b) centre of gravity of load under crane hook c) centre of gravity relative to rigging position and sling force
4.	Boom angle indicators vs boom deflection	1. Demonstrate use of boom angle indicators: a) exact radius over boom angle
5.	Slack rope on drums and uneven spooling	1. Identify reasons for the following faults: a) rope incorrectly installed on the drum b) incorrect fleet angle c) sheaves poorly lubricated d) sheaves stiff due to cold weather e) effect of wind on the hoist line (side wind) f) sudden stop as load is being hoisted g) hook block or headache ball to light h) sudden change in rope tension i) excessive speed when lowering hook block or headache ball
6.	Static load vs dynamic load	1. Define and describe static load vs dynamic load.
7.	Effect of overloading	1. Describe the effects and causes of overloading: a) tipping failure b) structural failure c) mechanical failure
8.	Outrigger use	1. Demonstrate the correct outrigger use (set up): a) tires off the ground as per manufacturer b) pads on firm footing c) pads to be at right angle and secured d) beams extended to manufacturer's specifications
9.	Stable ground	1. Identify safe ground stability for the operation of a crane: a) crane and ground pressure calculations b) outriggers pads blocking to reduce ground pressure
10.	Level the crane	1. Demonstrate proper procedures to level the crane: a) in the cab level b) on the carrier deck level c) on the base of turntable (carpenter's level) d) using hoist line
11.	Crane set up	1. Demonstrate proper set up for rubber tired mobiles: a) minimum swing clearance b) outrigger beams fully extended (most cranes) c) pads set on firm footing d) all tires off the ground e) crane level

		f) know weight of load g) know radius h) centre of gravity of load in line with hoist line i) site inspection for hazards
12.	Rig up and down procedures	1. Demonstrate procedures of rigging up or down for mobile cranes. 2. Describe safety procedures involved in rigging up or down mobile cranes.
13.	Operating	1. Measure the load radius. 2. Determine the total load from the net load. 3. Apply the total load to the values in the load capacity chart, area diagram and range diagram, to determine where the load can be placed prior to and after hoisting. 4. Give and follow standard crane hand signals. 5. Operate the equipment in a safe, smooth and controlled manner.
14.	Unattended for short/long periods	1. Describe and demonstrate procedures for leaving cranes unattended for extended periods by following manufacturer's instructions, codes and statutes, which includes: a) land any attached loads b) park on a level and stable area c) park on a safe and secure area d) set all brakes and locking devices, including swing brakes if they are used e) lubricate wire rope f) retract hydraulic booms and lower into cradle g) land any hooks or blocks on a clean, dry surface h) secure unit against accidental travel and movement by use of block or parking brake i) replace engine oil(s) j) ensure coolant is satisfactory for cold weather k) shut off power source(s) l) drain water/sediment from fuel filter(s) and tanks m) top off fuel tank(s) n) raise and block vehicle ensuring that wheels are clear of the ground o) lubricate crane and chassis as per maintenance procedures p) blank-off openings, such as air cleaner(s), turbo-charger, breather, etc. q) remove or ensure that batteries are fully charged and serviceable (disconnect leads if battery is left unattended) r) lock all controls and remove keys s) lock all doors
15.	Protection of personnel	1. Describe how to protect personnel in the vicinity of the lift by watching for danger areas: a) between counterweight and carrier b) between counterweight and obstruction c) bad side of crane d) between upper works and carrier

e) machinery deck
f) swing area of crane during operation
g) outrigger jacks during lowering
h) both extending and retracting outrigger beams
i) avoid swinging over people/property if possible
j) using barricades
k) using job rules and Alberta Occupational Health and Safety Act
l) ensuring when welding is being done
    i) the crane is properly grounded
    ii) welding cables are not dragged across the machine

16. Operating around high voltage equipment

1. Interpret provincial statutes and codes to determine procedures to use when working around high voltage equipment:
    a) operator responsibility
    b) site supervisor responsibility
    c) pre-job planning
    d) keeping your distance
    e) working near transmitters

2. Describe procedures to follow if electrical contact is made:
    a) operator remains at controls
    b) warn people away
    c) remove contact if possible
    d) escape procedure if you have to
    e) inspect crane for damage (recertification)

3. Describe how to operate around high voltage equipment considering:
    a) limits of approach as defined by statutes
    b) location of personnel
        i) only required personnel to be in area of lift
        ii) no one is to be simultaneously touching crane or load and ground
    c) notification of local utility company when and where crane is to be working
    d) obligatory use of designated signal person

17. Boom contact with obstructions

1. Describe the effect of the boom contacting an obstruction:
    a) load hitting or touching boom
    b) boom touching or resting on structure
    c) procedures that follow after a boom is contacted

18. Two-blocking

1. Describe how two-blocking occurs and procedures to prevent it:
    a) telescoping or lowering boom
    b) hook block or headache ball pulled into boom tip sheaves

19. Telescoping booms

1. Demonstrate procedures for telescoping booms:
    a) sections extended as per manufacturers' specifications

20. Cold weather operation

1. Describe cold weather operation below -20° Celsius:
    a) avoid maximum capacity lifts
    b) slow down cycle of operation
    c) consider dynamic or shock loading of any structural components
    d) properly warm up of hydraulic systems
    e) slow, smooth and infrequent lifting and only if necessary
    f) cold weather lifting as per manufacturers' specifications

TOPIC	OBJECTIVES	FIRST PERIOD

21.	Communication and signalling	1. Communicate with job supervisors about general job procedures. 2. Explain the proper use of audio signals to make the lift. 3. Use audio signals to lift, move, lower, and position various loads and when loads are out of view of the operator. 4. Describe types and characteristics of audio communicators. 5. Describe and demonstrate operation of audio communicators. 6. Describe effects of breath on mouthpiece in freezing weather. 7. Recognise hoist and crane operation terminology and movements. 8. Use and interpret international hand signals and determine their application for crane and hoist operations. 9. Describe when a signal person must be designated.
22.	On rubber lifting	1. Describe procedures for using and not using "on rubber" lifting as per the manufacturers' specifications.
23.	Pick and carry loads	1. Describe and demonstrate how to "pick and carry" loads with cranes following manufacturer's instructions/specifications in such areas as: a) "pick and carry" chart notes b) firm and level ground c) boom position i) "over the front" on rough terrain cranes ii) "over the rear" on truck mounted cranes (when permitted) iii) boom in line with the axis of the crane iv) boom as short as possible v) boom to be as low as possible vi) swing and/or house lock engaged (see manufacturer's specifications) d) load position: i) keep load as close to the ground as possible ii) keep load as close to the carrier as possible iii) tie load to carrier or control load with tag lines e) travel speed as per manufacturer's specifications f) move toward load if possible g) avoid sudden starts and stops

SECTION FIVE: .....RIGGING AND EQUIPMENT ACCESSORIES .....27 HOURS

A. Rigging and Equipment Accessories

1.	Wire rope	1. Describe the construction, types and functions of wire rope: a) wire b) strand c) core (fibre or wire or strand) 2. Describe proper procedures for cutting wire rope.
2.	Rope lay	1. Interpret and describe rope lay: a) regular lay b) lang lay

		c) right lay and left lay d) alternate lay e) herringbone or twin strand lay f) specialty ropes
3.	Sizes, grades and other factors	1. Describe and interpret sizes, grades and classification group (strand classification) of wire rope. 2. Compare preformed vs non-preformed types of rope. 3. Identify the fatigue and abrasion resistances of wire ropes. 4. Describe and interpret breaking strengths and safety factors for: a) rigging slings b) running ropes c) standing ropes 5. Calculate the "safe working load" by dividing the catalogue breaking strength by the factor of safety. 6. Demonstrate procedures for hoist rope changes. 7. Identify and describe uses for non-rotation or rotating resistant ropes. 8. Describe inspections and maintenance procedures for: a) lubrication b) cleaning 9. Describe procedures for installing end fittings and connections. 10. Ensure the correct number of wraps is left on the drums as per regulations.
4.	Rigging hardware and tools	1. Demonstrate proper use and application of: a) drums and winches b) sheaves c) hooks d) rings, links and swivels e) shackles f) eye bolts and lugs g) turnbuckles h) come-a-long and chain hoist i) load binder j) spreader, lift and equaliser beams k) crane load blocks l) wire rope blocks m) snatch blocks n) tackle blocks o) cable clamps
5.	Reeving	1. Demonstrate proper procedures for reeving and lacing load blocks.
6.	Slings	1. Identify and demonstrate proper use of: a) wire rope slings b) nylon web slings c) polyester and Kevlar d) sling configurations e) single vertical hitch

f) bridle hitch
g) single and double basket hitch
h) double wrap basket hitch
i) single and double choker hitch
j) double wrap choker hitch
k) sling angles
l) safe working loads
m) rule of thumb formulas
n) criteria
o) chain

2. Identity criteria for taking wire rope slings and hoist ropes out of service for:
   a) broken wires
   b) core failures
   c) localised damage
   d) lubrication

SECTION SIX: .....INSPECTION, TESTING AND MAINTENANCE .....9 HOURS

A. Inspection, Testing and Maintenance

1. Log book

1. Maintain an equipment log book as per owner's instructions and in accordance with the Occupational Health and Safety Act.
2. Record usage and work location of equipment as required by the owner.

2. Checks in the yard (before starting the engine)

1. Use and interpret manufacturer's manual to determine:
   a) items to inspect
      i) all fluids at sufficient levels, including fuel, crankcase oil, coolant, hydraulic
      ii) battery electrolyte level correct
      iii) belts, radiator hoses - in place and not damaged or frayed
      iv) a visual check for loose bolts/mountings around engines
      v) coolant or oil leaks
      vi) air cleaner and connections secure
      vii) drain cocks closed
   b) evidence of vandalism
   c) inspection procedures
   d) inspection schedule
   e) location of items to inspect
   f) location and function of control panel gauges
   g) safety guards - in place
2. Conduct pre-operational checks using tools such as:
   a) wheel wrench
   b) tire gauge
3. Explain the importance of checks prior to starting the engine.

3. Checks in the yard (with engine running)

1. Demonstrate the pre-operational checks to be made while the unit is running, engine brought up to operating temperature, and with crane on firm base:
   a) engine operation
      i) oil pressure - normal gauge reading

ii) temperature - normal gauge reading
iii) battery - not discharging, ammeter/voltmeter reading normal
iv) air cleaner indicators - gauge/light

b) air and hydraulic systems
i) pressure correct for operation (if equipped with a gauge)
ii) hoses - check for cuts, abrasions and bulging, ensure tight and leak-proof

c) hydraulic system
i) check for oil leakage
ii) filters: check gauge/warning light/alarm

d) all crane controls—operational (e.g. hoist, swing, boom telescoping, lower/raise load line, cab lock/brake, travel lock (dog w/pin-positive)
i) test anti-two-blocking devices by raising hook until contact is made
ii) back up alarm, warning flashers, bells or horns
iii) ensure hydraulic boom will telescope with sections extending equally or sequentially as per manufacturer's instructions

e) load weighing and moment devices are operational—check by using test circuits

f) safety and warning devices - operational

g) wire rope - check for wear and replace where necessary (replacement criteria is defined by manufacturers)

h) tires - check for cuts, abrasion and wear, adequate pressure

i) braking system
i) service brake check
ii) emergency and/or parking brakes are operational

j) steering
i) operational, correct alignment, and without excessive slackness

k) lighting—operational, includes
i) dash/control panels, floodlights, headlights, dome lights, running/clearance, back-up lights

l) fastening devices
i) on boom—pins and keepers in place

m) hooks and hook blocks
i) hook - check for cracks and deformation, hook should rotate freely
ii) sheave - without excessive wear and rotating freely

4. Maintaining

1. Maintain equipment (including some adjustments) as specified by the manufacturer, which includes:

a) engines
i) replace or clean filters when necessary or at prescribed intervals
ii) maintain coolant, correct level and condition
iii) maintain oil levels and replace oil when necessary or at prescribed intervals

b) hydraulic system
i) replace oils and filters when necessary or at prescribed intervals
ii) handle and use specified oil for ambient temperatures
iii) keep oil clean

iv) store oil correctly

c) air systems
   i) replace filters when necessary or at prescribed intervals
   ii) drain tanks when necessary

2. Describe and demonstrate precautions to be taken when carrying out maintenance according to manufacturer's instructions which include:
   a) all controls in the 'off' position and secured and tagged
   b) power plant rendered inoperable or disconnected at take off
   c) battery disconnected if in a dangerous situation
   d) boom secured against dropping
   e) maintenance person to be visible
   f) no working alone in dangerous or isolated situations
   g) disengage pump
   h) hydraulic and oil system pressure relieved before loosening components
   i) all components affected by maintenance checked and operational before returning to service

3. Interpret manufacturer's manual to determine:
   a) types of lubricants
   b) method of lubrication
   c) lubrication schedule

4. Identify the lubrication points for each component.

5. Maintain cranes/truck using:
   a) Hand-operated guns and oilers
   b) Pneumatic and pressurised equipment
   c) mobile lubricators and dispensers

6. Describe the functions, characteristics, types, and classification of lubricants.

SECTION SEVEN: ..... HYDRAULICS AND APPLICATIONS TO MACHINE CONTROL ..... 13.5 HOURS

A. Hydraulics and Applications to Machine Control

1. Power transfer and basics

1. Describe the principles of power transfer through hydraulic systems:
   a) basic principles of hydraulics
   b) how a hydraulic system works
   c) open and closed systems
   d) implications for crane hydraulics

1. Describe the transmission engine power through hydraulic power to such functions as:
   a) swinging/slewing
   b) boom/up/down
   c) boom extension and retraction of hydraulic booms
   d) hydraulic pumps and motors

2. Basic hydraulic system
   a) major components

1. Describe the construction and operation of a basic hydraulic system.

2. Describe how hydraulic fluid is used in the operation of:
   a) different types of valves

b) different types of pumps
   i) displacement of pumps
c) different types of hydraulic cylinders
   i) piston cylinders
   ii) cylinders on mobile cranes

b) hydraulic system components

1. Describe the operation of the hydraulic system components listed:
   a) motors
   b) accumulators
   c) filters
   d) reservoirs
   e) monitoring devices
   f) hoses and fittings
   g) adapters
   h) SAE O-rings, flangeheads
   i) seals

c) hydraulic fluids

1. Describe the qualities required for hydraulic fluids:
   a) properties of fluids
2. Describe the effect of cold weather and contaminants in a system.
3. Describe the maintenance of fluid levels and precautions when checking.

d) relation of electric systems to hydraulic systems

1. Describe relation of electric systems to hydraulic systems.
2. Identify the basic components listed and test and replace defective components:
   a) controls
   b) basic components
      i) solenoids
      ii) relays
   c) components and spools

e) hydraulic systems on mobile cranes

1. Identify hydraulic systems used for all types of mobile cranes and boom trucks:
   a) closed centre systems
   b) open centre systems
   c) Speed-O-Matic system (Link Belt)
   d) hydraulically-powered (lattice boom cranes)
   e) independent systems
   f) combined systems
   g) independent clutch
   h) independent steering
   i) hydraulic systems (Grove Cranes)
      i) boom lift system-hydraulic boom
      ii) boom extension system
      iii) swing system
      iv) hoist system
      v) outrigger system
      vi) hydraulic counter-weight exterior system
   j) lattice boom crane upperworks
      i) independent hydraulic system (gantry operation)
      ii) independent hydraulic system (boom operation)
      iii) independent hydrostatic drive system

3. Routine maintenance/inspection of crane hydraulic systems	1. Perform routine maintenance and inspections for crane hydraulic systems including: a) safety practices on a hydraulic system b) general safety precautions c) cleanliness and inspection d) reservoir inspection e) inspection for leaks f) leakdown i) outrigger leakdown ii) boom hoist cylinders leakdown iii) boom extension cylinders leakdown

SECTION EIGHT: .....POWER TRAINS, CHASSIS AND SUSPENSIONS .....9 HOURS

A. Power Trains, Chassis and Suspensions

1. Truck Crane (chassis components) a) chassis components	1. Identify the chassis components listed: a) main frame b) mounting supports c) outrigger supports d) power systems and components i) engine ii) clutch iii) torque converters iv) manual transmissions - main - auxiliary v) automatic transmissions vi) drive lines vii) drive shaft and universal joints viii) axles - rear axle assemblies - rear axle housing - rear axle shafts - rear and front axle suspensions ix) differential assembly x) differential assembly (drive unit) xi) planetary hub assembly xii) steering systems xiii) brake systems - drum brakes (S-cam actuators) - drum brakes (wedge actuators) - disc brakes (wedge actuators) - parking brakes
b) wheels (mobile and rough terrain)	1. Identify wheel and rim types. 2. Describe: a) applications b) servicing hazards c) bearings and lubrication d) tightening of wheel lugs

c) tires

1. Describe tire structure, application and maintenance including:
   a) importance of correct pressures
   b) service limitations (in the field)
   c) recognition of tire faults and failures
   d) recognition of "on-highway" and "off highway" type tires

d) lubrication and maintenance

1. Demonstrate lubrication and maintenance procedures following manufacturers' recommendations:
   a) fluid level checks
      i) engine and transmissions oil
      ii) hydraulic reservoir oil
      iii) coolant and electrolyte level
      iv) torque converter fluid
      v) rear axle and planetary oil
      vi) fuels
   b) engine support systems
      i) hoses and fasteners
      ii) drive lines and connections
      iii) wheels, tires and brakes

SECTION NINE: .....DIESEL ENGINES AND SYSTEMS .....9 HOURS

A. Diesel Engines and Systems (basic understanding)

1. Types of engines
   a) four-stroke diesel engine
   b) two-stroke diesel engine
   c) air-cooled diesel engine

1. Identify common types and designs of engines used for mobile cranes and boom trucks.

2. Engine lubrication system and components

1. Identify lubrication systems, parts and components.

2. Identify types of oil systems:
   a) full flow systems
   b) by-pass systems

3. Describe internal force feed and splash systems.

4. Describe full internal force feed system.

5. Identify and describe components:
   a) oil pump
   b) oil filter
   c) oil sump
   d) oil cooler
   e) oil lines and passages

3. Monitoring devices

1. Identify and inspect monitoring devices:
   a) pressure gauge
   b) oil temperature gauge
   c) sending unit
   d) automatic shutdown devices
   e) warning devices
   f) dipsticks

4. Methods of servicing

1. Identify types and grades of oils.

TOPIC	OBJECTIVES	FIRST PERIOD
a) filter maintenance and replacement b) engine oil selection c) safety precautions	2. Describe handling, storage and disposal procedures for oil and filters. 3. Demonstrate oil filter installation procedures and precautions. 4. Interpret and identify oil conditions. 5. Identify the presence of moisture bubbles (dip stick). 6. Demonstrate maintenance procedures required for lubrication systems of each manufacturer.	
5. Engine cooling system	1. Describe principles of operation for both systems: a) liquid-cooled systems b) air-cooled systems 1. Identify and describe the function of the components listed: a) radiator c) radiator cap d) hoses e) thermostat f) fan and belts g) vent and filters	
6. Monitoring devices	1. Identify and describe the purpose for the monitoring devices: a) warning devices b) testing devices	
7. Servicing procedures	1. Describe and understand purpose for servicing the cooling system: a) cleaning b) draining c) flushing the system 2. Identify proportions of coolant solutions required for cooling systems: a) install and test antifreeze mixture 3. Describe handling, storage and proper disposal of coolant solutions. 4. Demonstrate testing methods and interpretation of coolant testing. 5. Describe the reason for using inhibitors in cooling systems. 6. Describe remove and replace methods for: a) belts b) hoses, etc.	
8. Air intake systems	1. Identity the parts and components listed. a) air filters b) intake manifold c) supercharger d) turbocharger 2. Describe starting aids and precautions for: a) starting fluid gaseous mixture b) glow plugs 3. Describe purpose of the intake air heater. 4. Identify and describe purpose for the air system monitoring device.	

5. Demonstrate servicing procedures for the air intake system:
   a) inspection
   b) frequency of servicing
   c) cool-down procedure
   d) precleaner service
   e) changing filters
   f) cleaning system

9. Fuel systems (basics)

1. Identify types and grades of fuels.

2. Describe and demonstrate handling and storage precautions.

3. Identity major components of the fuel system:
   a) reservoir
   b) filters
   c) metering system
   d) injectors system
   e) pump monitoring device

4. Demonstrate care and maintenance of fuel systems including:
   a) filters

5. Describe the use of fuel return systems.

6. Describe the circuit analysis of a fuel system.

7. Describe and demonstrate the starting of an engine after running out of fuel.

10. Electrical system
    a) batteries

1. Identity and describe principles of operation for the parts or systems listed.

2. Identity sizes, capacity and types of batteries.

3. Interpret battery terminology and descriptions.

4. Demonstrate battery care and maintenance:
   a) maintain electrolyte level
   b) clean as necessary and tighten terminals
   c) inspect for defective posts, cables, etc.
   d) replace if necessary

5. Test and identify a total or partial failure of a battery:
   a) hydrometer readings
   b) voltage drop

b) circuitry and wiring
   i) circuits
   ii) circuit defects
   iii) circuit symbols
   iv) fuses

1. Identify different electrical circuits:
   a) series
   b) parallel
   c) series-parallel

2. Identity circuit defects for:
   a) shorts
   b) grounds

3. Identify simple circuit symbols:
   a) positive
   b) negative

		c) ground d) battery
		4. Describe and demonstrate maintenance procedures for electrical circuits: a) cleaning and securing contacts b) replacing damaged wiring, fuses and bulbs c) checking gauges, heaters and fans
	c) starting system	1. Demonstrate procedures to service and maintain starting systems: a) starters b) parallel/series switch c) resistors d) terminals
	d) charging system	1. Demonstrate procedures to service and maintain the charging system: a) alternators b) belts c) regulators
	e) ignition system	1. Identify and inspect the ignition system for visible defects.
	f) monitoring devices	1. Identify and interpret the various monitoring devices.
	g) ammeter and voltmeter	1. Identify and interpret ammeter and voltmeter readings.
	h) shut-down solenoid	1. Identify and describe the purpose of the shut-down solenoid.
	i) electric signal generator	1. Identify and describe the purpose of the electric signal generator.
	j) procedure to service electrical systems	1. Demonstrate and identify procedures to service all electrical systems.
11.	Air systems	1. Describe the operations of the air systems considering critical components such as: a) compressors b) air tank location and drainage c) coolers d) controls i) unloader valve ii) safety relief valve e) gauges i) service ii) emergency
		2. Describe the function, servicing and benefits of an air dryer.
		3. Describe the effect of cold weather and condensation on the air system.

SECTION TEN:..... RULES AND REGULATIONS RELATING TO THE TRADE..... 18 HOURS

A. Rules and Regulations Relating to the Trade

1.	Alberta Occupational Health and Safety Act	1. Describe personal and equipment safety. 2. Observe safe working habits to prevent accidents.

		3. Identify procedures in case of an accident. 4. List the sections in OH & S that apply to the Crane and Hoisting Equipment Operator trade: a) general provisions b) general provisions respecting machinery c) safeguards, warning signs and alternative precautions d) access and egress e) personal protective equipment f) powered mobile equipment and other vehicles g) hoisting and hoists h) rigging i) excavations, trenches, tunnels and underground shafts j) fire and explosion hazards k) demolition work
2.	CSA/Canadian Standard Association Z150	1. Describe the statutes and codes affecting mobile crane operation: a) scope b) definitions and terminology c) construction and characteristics of mobile cranes with rope suspended booms d) construction and characteristics of mobile cranes with hydraulic booms e) inspection, testing and maintenance f) operation
3.	Workplace Hazardous Materials Information System (WHMIS)	1. Describe what WHMIS is, its rational and major elements. 2. Define what is meant by a WHMIS label and distinguish between supplier and workplace labels and other means of identification.
4.	Fire prevention and control a) classes of fires	1. Identify the classes of fires: a) class A - ordinary combustibles, wood, paper, packing, etc. b) class B - petroleum and synthetic materials: paint, gasoline, etc. c) class C - equipment, electrical, internal combustion, etc. d) class D - combustible materials, magnesium, etc.
	b) fire extinguishers	1. Identify the common types of fire extinguishers: a) water; stored pressure, cartridge operated, soda acid b) dry chemical c) carbon dioxide (CO_2) d) multi purpose
	c) fire extinguisher use	1. Describe the applications and limitations of fire extinguishers including: a) effectiveness in relation to the stage of the fire
	d) fire extinguisher servicing	1. Describe the recommended cycles for servicing and by whom.
	e) fire hazards	1. Identify potential fire hazards that can be caused by: a) faulty wiring and equipment b) leaking containers and accumulations of oily trash c) improper methods of handling flammables
5.	Transportation rules and regulations	1. Identify and interpret transportation rules and regulations.

TOPIC	OBJECTIVES	FIRST PERIOD
6. Transportation procedures a) weights b) dimensions c) stipulated time limits d) long or wide loads	1. Identify weight and dimension limits with interpretation of municipal and weights of provincial highway regulations: a) Alberta Highway and Safety Act b) Occupational Health and Safety Act (construction and general) c) Z150 Canadian Standards Association (latest version) d) Motor Transport Act - Public Vehicle Dimension Regulation - Public Vehicle Weight Regulation - dimensions - stipulated time limits - long or wide loads - loading crawlers - loading rubber tired equipment - loading boom components - load safety precautions and procedures	

THIRD PERIOD TECHNICAL TRAINING
CRANE AND HOISTING EQUIPMENT OPERATOR
MOBILE CRANE OPERATOR

OBJECTIVE:

To instruct the apprentice in the following major trade areas:

1. Review of materials from first period.
2. Read and interpret lift studies.
3. Correct use and application of computer assisted safety devices.
4. Introduction to specialised lift attachments.
5. Demonstrate and apply advanced rigging procedures.
6. Introduction to multi-crane lifts.
7. Explain and demonstrate operating techniques.
8. Demonstrate rig down and up procedures.
9. Introduction to new technology for mobile cranes.
10. Explain and demonstrate proper pre-lift planning.
11. Interpret load chart data.
12. Demonstrate proper operating procedures.

THIRD PERIOD TECHNICAL TRAINING
CRANE AND HOISTING EQUIPMENT OPERATOR
MOBILE CRANE OPERATOR
COURSE OUTLINE

TOPICS	OBJECTIVES Upon successful completion of this unit the apprentice should be able to:
SECTION ONE: .....REVIEW OF MOBILE CRANES AND COMPONENTS .....9 HOURS	
A. Mobile Cranes and Components	
1. Types and configurations	1. Review the types and configurations of cranes: a) mobile cranes b) lattice boom cranes c) boom trucks
2. Crane upperworks (superstructure)	1. Identify the main components of the upperstructure listed: a) machinery deck/revolving frame b) slewing ring rollers or slewing bearing c) boom foot pins and lugs d) counterweight e) boom hoist drums and drives (winches) f) centre of rotation (centre or king pin)

3. Carrier-mounted (truck crane)	1. Identify the components of truck cranes listed: a) undercarriage or chassis b) swing circle, ring gear, roller path (turntable) c) outrigger boxes, beams and cylinders d) outrigger jacks or stabilisers and pads or floats e) front bumper jack or stabiliser (optional) f) outrigger controls g) front bumper counterweight (optional)
4. Crawler-mounted (crawler crane)	1. Identify the components of crawler cranes listed: a) car body frame and axles b) swing circle, ring gear, roller path (turntable) c) side frames, (extendable and not extendable) d) idler rollers e) track rollers (support rollers) f) tread sprockets or drive sprockets g) drive shaft sprockets and drive chains h) traction shafts i) hydrostatic track drive systems on modern crawler cranes
5. Telescopic boom cranes	1. Identify the components of the telescopic cranes listed: a) boom b) hoist or lift cylinder(s) c) boom foot pins (hinge pins) d) base or heel section e) power telescoping sections f) pinned boom sections g) main and auxiliary boom tip sheave(s) h) boom extension and jib stowed support i) main hook block and auxiliary hook ball j) hoist lines with LMI/anti two-block devices k) jib l) lattice boom extension (swingaway type jib) m) A-frame jib n) jib off-set link (optional) o) box section jib (stinger type) p) luffing jib q) jib deflection sheave r) tip sheave s) jib inserts (optional) t) jib backstays (adjustable for jib offset) u) jib forstays v) jib mast or strut

SECTION TWO:..... PRINCIPLES OF CRANE OPERATION..... 13.5 HOURS

A. Principles of Crane Operation

1. Principal of leverage	1. Describe the principles of leverage and the relationship between leverage and stability. 2. Define the following terms: a) leverage of a crane b) leverage of a load c) tipping axis d) centre of rotation e) centre of gravity

3. Identify the centre of gravity of major crane components:
   a) boom
   b) carrier
   c) upperworks
   d) counterweight

4. Identify the symbol of gravity.

5. Determine the centre of gravity for major cranes:
   a) centre of gravity of a crane
   b) centre of gravity of a load
   c) centre of gravity location during rotation of upperworks

6. Describe the leverage principle.

7. Define fulcrum and how it applies to crane operation.

8. Describe the effect of structural strength and leverage on a cranes ability to lift a load.

9. Describe the basic mechanical advantage of leverage systems and the leverage systems used in craning:
   a) class 1 lever
   b) class 2 lever
   c) class 3 lever

10. Describe the load's leverage including:
    a) leverage and stability
    b) stability vs instability
    c) effect of tipping axis's location on stability and capacity

11. Describe changes in crane leverage during rotation of upperworks:
    a) most stable area
    b) less stable area
    c) least stable area

12. Describe changes in crane capacity during rotation of upperworks for:
    a) most capacity
    b) less capacity
    c) least capacity

13. Describe the load moment for:
    a) tipping moment
    b) resisting moment

14. Describe the tipping axis's location as upperstructure rotates.

15. Describe forward stability rating in percentage of tipping for:
    a) crawler tracks
    b) truck cranes and rough terrain
        i) on outriggers
        ii) on rubber
    c) boom trucks

16. Describe backward stability for a crane.

17. Describe static load vs dynamic load.

18. Identify and describe effective weight:
    a) more effect on the load
    b) less effect on the load
    c) no effect on the load

19. Describe the effect of the load on the boom:
    a) lattice booms
        i) compression
    b) telescopic booms
        i) load on boom hoist
        ii) cylinders (high angle)
        iii) load taken on the boom in bending (as the boom is lowered)

20. Describe the effect of pendant angle on lattice booms for:
    a) gantry
    b) live mast
    c) high mast

21. Describe the effect of overloading a crane:
    a) tipping failure
    b) structural failure
    c) mechanical failure

2. Areas of operation

1. Describe the importance of areas for operation for cranes.

2. Identify the sweep area.

3. Describe the division of sweep area into quadrants.

4. Describe and identify working areas for:
   a) rough terrain cranes
   b) carrier-mounted cranes
   c) crawler-mounted cranes
   d) boom trucks

SECTION THREE: ..... LOADS CHARTS ..... 27 HOURS

A. Loads Charts

1. Basic terms and conditions

1. Have a through understanding of load charts for:
   a) boom lengths
   b) operating radius
   c) boom angle
   d) boom point elevations
2. Explain the difference between gross capacity vs net capacity.
3. Explain the difference between gross load vs net load.
4. Calculate the percentage of the gross load based on 75 to 85%.
5. Determine if capacity is limited by structural strength or stability:
   a) shaded areas used for structural rating
   b) bold line divides the two areas
   c) asterisks or stars used for structural rating
6. Identify the configuration of the crane base:
   a) 360° chart on outriggers and rubber
   b) over the side and rear chart (some truck cranes)
   c) over the front
      i) front idlers blocked (some crawlers)
      ii) no swinging or limited swing (see chart notes)
      iii) front outrigger set (some truck cranes)
      iv) over the rear chart
7. Determine on rubber rating from the charts for:
   a) pick and carry
   b) over the front rating
   c) 360° rating

2. Configuration of crane upperstructure

1. Use load charts to determine the configuration of a crane's upperstructure:
   a) without counterweight chart
   b) with some or all counterweight chart
   c) with counterweight extended or retracted
   d) with or without live mast chart
   e) gantry position (raised, lowered or mid position)
   f) boom length
2. Identify boom lengths required including:
   a) boom length definition
   b) boom length between chart listing

		3. Identify boom angle required including: a) boom angle definition b) boom angle between chart listing 4. Identify load radius required including: a) load radius definition b) load radius between chart listings 5. Identify the boom hoist and load hoist lines required including: a) breaking strength b) safety factor i) crane in working position ii) raising boom from horizontal iii) safe working load 6. Determine the parts of line required taking into account the following: a) sheave friction b) line pull c) safe working load of wire rope 7. Determine the weight of the hoist line required. 8. Determine with the use of range diagrams the following: a) crane configuration b) boom clearance c) boom tip headroom 9. Identify the areas of operation. 10. Calculate main boom capacities (no attachments): a) lattice b) full power telescopic booms c) pinned telescopic booms i) select gross capacity from (main boom) load chart ii) determine number of parts of line and hook required iii) deduct all hook blocks, headache balls and rigging iv) deduct auxiliary boom point and stowed jib and/or boom extension (if applicable) v) deduct weight of parts of line exceeding those allowed by the manufacturer
3.	Main boom capacities (jibs and boom extensions installed)	1. Calculate main boom capacities (jibs and boom extensions) installed: a) calculating capacities for lattice booms b) calculating capacities for full power telescopic booms c) calculating capacities for pinned telescopic booms i) select "gross capacity" from (main boom) load chart ii) determine number of parts of line and hook required iii) deduct all hook blocks, headache balls and rigging iv) deduct effective weight of jib and/or extensions mounted v) deduct auxiliary boom point and stowed jib and/or boom extension (if applicable) vi) deduct weight of parts of line exceeding those allowed by the manufacturer
4.	Boom extensions capacities	1. Calculate boom extension capacities for: a) calculating capacities for full power telescopic booms b) calculating capacities for pinned telescopic booms i) select "gross capacity" from (boom extension) load chart

ii) determine number of parts of line and hook required
iii) deduct all hook blocks, headache balls and rigging
iv) deduct effective weight of jib if mounted
v) deduct auxiliary boom point and stowed jib (if applicable)

5. Jib capacities

1. Calculate jib capacities for:
   a) jib types and length
   b) jib offset
   c) jib angle to the ground
   d) jib capacity for lattice booms
   e) jib capacity for full power telescopic booms
   f) jib capacity for pinned telescopic booms
      i) jib capacities using one load chart
      ii) jib capacities using two load charts
      - structural capacity from jib chart
      - tipping capacity from boom chart
      - use lowest capacity from the two

6. Factors influencing capacity

1. Identify and describe factors which influence capacity:
   a) geometry and configuration of crane
      i) manufacturer's specifications
      ii) boom and jib configuration
      iii) counterweights
      iv) gantries and high masts
      v) crawler tracks (extended or retracted)
   b) areas of operation
   c) outrigger beams extension
      i) 100% extended (most cranes)
      ii) 50% extended option (see load chart)
      iii) 0% extended option (see load chart)
   d) boom length
   e) boom angle
   f) load radius
   g) deductions from gross capacity

7. Factors affecting capacity

1. Identify and describe factors which affect capacity:
   a) machine condition
   b) eccentric reeving
   c) improper use of outriggers
      i) on "rubber" rating
      ii) on "outriggers" rating
   d) ground condition
   e) off-level crane
   f) side loading
   g) increase of load radius
   h) rapid swing rate
   i) impact loading
   j) crane de-rating per manufacturer's specifications
      i) dragline work
      ii) claming
      iii) concrete placing
      iv) steel erection
      v) others specialised operations
   k) weather (wind, ice, moisture, frost)
   l) operator experience

TOPIC	OBJECTIVES	THIRD PERIOD

SECTION FOUR: ..... OPERATING PROCEDURES ..... 27 HOURS

A. Operating Procedures

1. Responsibilities	1. Identify the responsibility of each person regarding operating procedures: a) crane operator i) workplace coaching skills, describe the following coaching skills used for training apprentices: - identify the point of the lesson - link the lesson - demonstrate a skill - provide opportunity to practice a skill - give feedback to the learner - assess the learner's progress b) rigger/signal person c) maintenance person(s) d) site supervisor e) crane owner
2. Weights of loads	1. Identify weights of loads using available means: a) information shown on load itself b) source of weight information, e.g. drawings, shipping bills (not always reliable), catalogues, etc. c) use of load weighting devices d) estimating weighing using accepted industry formulas (volume, density and area)
3. Centre of gravity of the load	1. Determine the centre of gravity of the load: a) stable vs unstable b) relative to rigging position and sling force c) centre of gravity of load under crane hook
4. Critical lifts	1. Define and determine a critical lift: a) precautions to be taken b) lift study
5. Boom angle indicators and critical lifts	1. Demonstrate use of boom angle indicators: a) exact radius over boom angle
6. Slack rope on drums and uneven spooling	1. Identify reasons for slack rope on drums and uneven spooling including: a) rope incorrectly installed on the drum b) incorrect fleet angle c) sheaves poorly lubricated d) sheaves stiff due to cold weather e) effect of wind on the hoist line (side wind) f) sudden stop as load is being hoisted g) hook block or headache ball too light h) sudden change in rope tension i) excessive speed when lowering hook block or headache ball

TOPIC	OBJECTIVES	THIRD PERIOD

7.	Protection of personnel	1. Demonstrate procedures to protect personnel during the lift by watching for these danger areas: a) between counterweight and carrier b) between counterweight and obstruction c) between upper works and carrier d) machinery deck e) swing area of crane during operation f) outrigger jacks during lowering g) extending and retracting outrigger beams
8.	Working near powerlines	1. Describe safety procedures when working near powerlines for: a) operator responsibility b) site supervisor responsibility c) pre-job planning d) rules and regulations (OH & S) e) keeping your distance f) in the event of contact g) bailout procedure h) working near transmitters
9.	Hitting the boom	1. Describe the effect on the boom when the following happens: a) load hitting or touching boom b) boom touching or resting on structure c) boom design (compression vs bending)
10.	Two-blocking	1. Describe how two-blocking happens and the results: a) telescoping or lowering boom b) hook block or headache ball pull into boom tip sheaves
11.	Telescoping booms	1. Describe how to telescope the following manufacturer's instructions: a) powered section extended equally b) newer cranes designed for sequencing of boom sections
12.	Backward collapse of booms (lattice boom)	1. Describe the reasons for the backward collapse of booms: a) boom operated at higher boom angle than permitted b) sudden forward movement when at high boom angle c) hook block tie back to boom foot and then pulled tight d) sudden release of load e) high wind speeds acting on the front of the boom f) hook block or headache ball pull against the boom tip sheaves g) swinging from the downhill side to the uphill side h) starting or stopping the swing motion suddenly
13.	Cold weather operation below -20° Celsius	1. Describe procedures necessary when temperatures fall within cold weather operations: a) avoid maximum capacity lifts b) slow down cycle of operation c) no dynamic or shock loading of any structural components d) proper warm up of hydraulic system e) slow, smooth and infrequent lifting and only if necessary f) lifting not recommended below -40° Celsius
14.	Signalling	1. Interpret and use international signals designed for hoisting operations: a) use and interpret hand signals b) use audio or radio signals

TOPIC	OBJECTIVES
15. On rubber lifting	1. Identify and describe procedures and precautions for on rubber lifting: a) avoid "360° on rubber lifting" if not necessary b) read carefully and understand rubber chart notes c) firm and level ground d) use of jibs and boom extensions prohibited e) automatic axle lock-out engaged f) tire size and type per manufacturer's specifications g) tires inflated per manufacturer's specifications h) "over the front" rating on rubber with limited swing (see load rating notes)
16. Pick and carry operations	1. Identify and describe procedures and precautions for pick and carry operations: a) read carefully and understand "pick and carry" chart notes b) firm and level ground c) boom position i) "over the front" on rough terrain cranes ii) "over the rear" on truck mounted cranes (when permitted) iii) "over the front idlers" on crawler mounted cranes iv) boom in line with the axis of the crane v) boom as short as possible vi) boom to be as low as possible
17. Swing and/or house lock engaged (see manufacturer's specifications)	1. Identify and describe procedures and precautions when lifting loads with the swing and/or house lock engaged: a) load position: i) keep load as close to the ground as possible ii) keep load as close to the carrier as possible iii) tie load to carrier or control load with tag lines b) travel speed to be as low as possible c) move toward load if possible d) avoid sudden starts and stops
18. Working with jibs	1. Identify and describe procedures and precautions when working with jibs: a) jib offset to main boom b) jib angle to ground c) jib capacity (strength or tipping rating)
19. Leaving cranes unattended	1. Identify and demonstrate procedures for leaving cranes unattended for: a) short periods b) extended periods

SECTION FIVE: ..... INTRODUCTION TO PRE-LIFT PLANNING ..... 27 HOURS

A. Pre-Lift Planning and Tasks

1. Site Preparation	1. Inspect access to the crane site to ensure area is compacted, graded and free from hazards: a) access roads adequate b) operating locations firm and level c) operating locations away from trenches d) blocking and/or hardwood mats available e) operating locations away from power lines

		f) sufficient room for crane erection g) access to site restricted to authorised personnel h) competent personnel only (rigging crew)
2.	Crane selection	1. Determine the crane configuration and attachments required for the lift taking into consideration pre-calculated gross load in accordance with manufacturers' manuals, OH&S policy.
3.	Crane set up	1. Demonstrate proper crane set up.
	a) crane set up	2. Locate the crane on firm level ground with outriggers extended and stabilisers set: a) correct outrigger use (set up) i) tires off the ground as per manufacturer's recommendation ii) pads on firm footing iii) pads to be at right angle and secured iv) beams extended to manufacturers specifications
	b) crane and ground pressure calculations	1. Determine ground stability ensuring soil is compacted and graded, adequate distances from embankments and structures, and free of hazards. 2. Demonstrate calculations of maximum outrigger or track loadings: a) outriggers pads blocking to reduce ground pressure b) crawlers i) least ground pressure (over sides) ii) higher ground pressure (over the ends) iii) highest ground pressure (over the corners)
	c) levelling the crane	1. Level the crane with ground by raising or lowering the outrigger jacks, blocking, and ensuring crane is level using a levelling device: a) in the cab level b) on the carrier deck level c) on the base of turntable (carpenter's level) d) using hoist line
	d) set up for rubber tired mobiles	1. Set up rubber tired mobile cranes as per manufacturers' instructions: a) minimum swing clearance b) outrigger beams fully extended (most cranes) c) pads set on firm footing d) all tires off the ground e) crane level f) know weight of load g) know radius h) centre of gravity of load in line with hoist line
	e) set up for crawler mobile cranes	1. Set up crawler mobile cranes as per manufactures' instructions: a) minimum swing clearance b) crawlers on firm footing over track area c) crane level d) crawlers locked e) know weight of load f) know radius g) C of G of load in line with hoist line

h) assembly (disassembly) of lattice boom
   i) following manufacturer's specifications
   ii) understanding boom configuration for specific crane
   iii) safety precautions when working around booms
   iv) load on boom pins (bottom/top pins)
   v) inserting and removing of boom pins
   vi) handling of boom sections
   vii) pendant lines and pendant spreader bar
   viii) cantilevered length
   ix) final inspection before raising boom
   x) precautions when raising (lowering) long booms off ground

2. Demonstrate procedures of rigging up or down for crawler cranes.

3. Describe safety procedures involved in rigging up or down crawler cranes.

4. Demonstrate operating procedures:
   a) measure the load radius
   b) determine the total load from the net load
   c) apply the total load to the values in the load capacity charts, area diagram and range diagram to determine where the load can be placed prior to and after hoisting
   d) give and follow standard crane hand signals
   e) operate the equipment in a safe, smooth and controlled manner

5. Describe transporting procedures for crawler cranes.

f) lift study drawings

1. Explain and interpret lift study drawings.

2. Demonstrate the use of a lift study to perform a set-up.

SECTION SIX: ..... ADVANCED RIGGING PROCEDURES ..... 27 HOURS

A. Advanced Rigging

1. Wire rope

1. Identify and describe the composition of wire rope:
   a) wire
   b) strand
   c) core (fibre or wire or strand)

a) rope lay

1. Interpret and describe rope lay:
   a) regular lay
   b) lang lay
   c) right lay and left lay
   d) alternate lay
   e) herringbone or twin strand lay
   f) specialty ropes

2. Identify specialty ropes and how/where they are used including limitations.

b) size, construction and grades

1. Describe and interpret sizes, grades and construction of all types of rigging and hoisting ropes.

c) preformed vs non-preformed rope	1. Identify and compare preformed vs non-preformed types of ropes.
d) fatigue and abrasion resistance e) breaking strength	1. Identify and describe the fatigue and abrasion resistances of wire ropes.
f) safety factors	1. Identify safety factors for: a) rigging slings b) running ropes c) standing ropes
g) safe working loads	1. Calculate safe working loads.
h) classification group	1. Identify the classification group: a) strand classification
i) non-spin or anti-rotating ropes	1. Identify and describe uses for non-rotation and rotating resistant ropes.
j) installation	1. Demonstrate proper installation and procedures for all types of wire rope.
k) inspection and maintenance	1. Inspect, use and handle and maintain wire rope: a) lubrication b) cleaning
l) end fittings and connections	1. Identify and install end fittings and connections.
m) minimum rope wraps on drum	1. Maintain the minimum rope wraps on a drum as per regulations.
2. Chain	1. Identify grades of chain including: a) strength b) inspection c) care and use of
3. Rigging hardware and tools	1. Identify and demonstrate use of: a) drums and winches b) sheaves c) hooks d) rings, links and swivels e) shackles f) eye bolts and lugs g) turnbuckles h) come-a-long and chain hoist i) spreader and equaliser beams j) crane blocks k) wire rope blocks l) snatch block m) tackle blocks
4. Reeving	1. Describe and define reeving. 2. Determine the parts of line required.

TOPIC	OBJECTIVES	THIRD PERIOD
	3. Describe the effect of winch diameter for: a) multi layer (wire rope) b) line speed vs torque	
	4. Determine sheave loads.	
	5. Determine the SWL of rope vs line pull.	
	6. Describe the effect of sheave friction during a lift.	
	7. Identify the mechanical advantage of reeving.	
	8. Demonstrate wire block reeving methods: a) lacing b) square or angle reeving c) skip reeving	
5. Slings	1. Identify and describe types and configurations for slings including: a) wire rope slings b) nylon web slings c) polyester and Kevlar d) metal mesh slings e) chain slings f) sling configurations g) single vertical hitch h) bridle hitch i) single and double basket hitch j) double wrap basket hitch k) single and double choker hitch l) double wrap choker hitch m) endless slings or grommet slings n) braided slings o) sling angles p) safe working loads	
	2. Read and interpret supplier, manufacturer and rigging manual.	
	3. Describe rigging precautions when using nylon and specialty slings.	
	4. Assemble rigging in a safe and efficient manner.	
	5. Select appropriate rigging hardware.	
	6. Perform maintenance and properly store rigging.	
	7. Calculate safe working loads and sling angles.	
	8. Identify frayed, cut, damaged and worn equipment and remove from service if necessary.	
6. Advanced rigging	1. Demonstrate proper rigging procedures and calculations.	
	2. Demonstrate and plan rigging operations.	
	3. Describe the reasons for using competent personnel.	
	4. Use the proper methods for determining load weights.	
	5. Determine the centre of gravity for various loads.	

6. Determine tensions on sling legs.
7. Calculate loads on equaliser beams.
8. Demonstrate proper signalling for hoisting procedures.

SECTION SEVEN: ..... INTRODUCTION TO NEW CRANES ..... 13.5 HOURS

A. New Technology

1.	General description of an AT crane	1. Field trip optional to review and study. 2. Identify and describe an AT/all terrain cranes for the following: a) crane sizes available b) range of capacities available c) range of boom lengths available d) manufacturers e) advantages/disadvantages
2.	Upperstructure characteristics	1. Describe the upperstructure characteristics of AT/all terrain cranes: a) boom technology b) telescoping and pinning systems c) heavy lift attachments
3.	Chassis characteristics	1. Describe chassis characteristics of RT/all terrain cranes: a) numbers of axles b) ratio of driven axles to idling axles c) suspensions systems d) general operation
4.	Load rating chart	1. Interpret the load rating charts.
5.	Terminology and symbols	1. Interpret new terminology and symbols.
6.	Control technology	1. Interpret new control technology: a) load moment evaluation computer systems b) ramping valves c) operational consideration
7.	Computer safety devices	1. Use and apply computer assisted safety devices, LMI/load indicators: a) central unit b) load transducers or load cells c) boom length and angle d) anti-two block e) read out (inside cab)

SECTION EIGHT: ..... CONVENTIONAL CRANE DRAW-WORKS ..... 13.5 HOURS

A. Conventional Drive Principles and Operation

1.	Crawler crane (car body components)	1. Identify and describe the drive principles and operation for the crawler crane (car body components): a) track frames b) track assemblies c) front tumbler assembly d) rear drive sprocket assembly

e) drive chains
f) drive sprocket and shaft assembly
g) track pads assembly
h) track carrier roller
i) car body assembly
j) car body axles
k) car body housing
l) travel components
m) turntable
n) travel systems and components
   i) mechanical propel system
   ii) vertical shaft assembly
   iii) lower bevel gear case
   iv) horizontal travel shaft assembly
   v) intermediate travel shaft assembly
   vi) steering
      - jaw clutch with mechanical lock assembly
      - jaw clutch with brake drum/brake shoe assembly
   vii) travel lock assembly mechanical locks **(both directions)**
      - digging locks (either directions)
      - brake drum/brake shoe assembly
   viii) hydraulic propel system
   ix) hydrostatic drive
o) maintaining and adjusting of lowerworks
   i) track assemblies
      - track pads
      - track tumblers
      - track rollers
      - drive sprockets and chains
   ii) car body assemblies
      - roller path and ring gear
      - anti friction bearing turntable
      - vertical travel shaft
      - lower bevel gear case
      - intermediate travel shaft assembly
      - jaw clutches

2. Upperworks components

1. Identify and describe the upperworks components of crawler cranes:
   a) house
      i) house structure
      ii) main revolving frame
      iii) engine
      iv) fuel tank
      v) machinery deck
      vi) cab and controls
   b) upperworks mounting and swing systems
      i) house rollers
      ii) hook rollers
      iii) dual function rollers
      iv) centre pin
      v) bearing type roller path
         - ball bearing type
         - roller bearing type
      vi) swing gear

TOPIC	OBJECTIVES	THIRD PERIOD

3. Upper machinery (power train)

1. Identify and describe the upper machinery (power train) for crawler cranes:
   - a) torque converter
     - i) components
       - the impeller wheel
       - the turbine
       - the housing
       - the inboard freewheel
     - ii) principles of operation
     - iii) lubrication
     - iv) fluid converter
     - v) cooling system
   - b) master clutch
     - i) over centre type
     - ii) location
     - iii) primary function
   - c) transmission case
     - i) dual torque converters and vicon systems
   - d) primary drive (drive chain)
     - i) enclosed in chain case
     - ii) lubrication systems
       - by running in oil
       - by pump/oiler system
   - e) gear train
     - i) principle of gear ratio
     - ii) idle gear
     - iii) internal gear
     - iv) planetary gearing
     - v) bevel gear
   - f) hoist drum assembly
     - i) drum
     - ii) drum shaft
     - iii) drum brake
     - iv) hoist clutch
     - v) reverse clutch
     - vi) power lowering (see vicon machine)
   - g) swing assembly
     - i) bevel gear and swing shafts drive
     - ii) swing clutch
       - internal expanding clutch type
       - disc clutch type
     - iii) swing brake
     - iv) positive swing lock
     - v) hydrostatic swing system
     - vi) magne torque swing system
   - h) boom hoist assembly
     - i) dual drum boom hoist system (only)
       - bevel gear and boom hoist shafts drive
       - boom hoist worm gear/shaft housing
       - hydraulic driven boom hoist system
     - ii) boom hoist clutch
       - internal expanding clutch type (raise and lower)
       - disc clutch type (raise and lower)
       - over running clutch type or sprag clutch

iii) automatic boom hoist brake
iv) auxiliary boom hoist brake (not all machines)
v) boom hoist pawl or dog

4. Lubrication, maintenance and adjustment

1. Demonstrate lubrication, maintenance and adjustments following manufacturer's specifications.

SECTION NINE: ..... SPECIALISED LIFT ATTACHMENTS ..... 9 HOURS

A. Attachments and Accessories

1. Attachments

1. Identify and describe uses for the attachments listed:
   a) tower attachment
   b) luffing jib attachment
   c) removable boom extension jib
   d) derrick attachment
   e) super-lift attachment
   f) pile hammer attachment
   g) ring attachment
   h) sky horse
   i) sliding gantry
   j) jacking systems
   k) stiff legs

2. Accessories

1. Identify the accessories listed:
   a) personnel basket
   b) dragline
   c) clam
   d) magnet
   e) demolition ball
   f) grapples
   g) augers

1. Identify and interpret regulations pertaining to personnel baskets.

2. Identify and apply safety precautions for the accessories listed.

SECTION TEN: ..... MULTI-CRANE LIFTS ..... 13.5 HOURS

A. Multi-Crane Lifts

1. Multi-crane lifts

1. Describe multi-crane lifts as to:
   a) lift to be planned and carried out by qualified supervision
   b) weight transfer of load
   c) lift study may be required
   d) maximum load on each crane shall be determined exactly
   e) travelling with the load should be avoided
   f) one person to control and direct operation during actual lift

2. Describe reasons why it is recommended that loading on each crane should not exceed 75% of capacity as measured on the lifting chart or an engineer's recommendation.

Alberta Apprenticeship and Industry Training

Excellence through training and experience

34-1-00